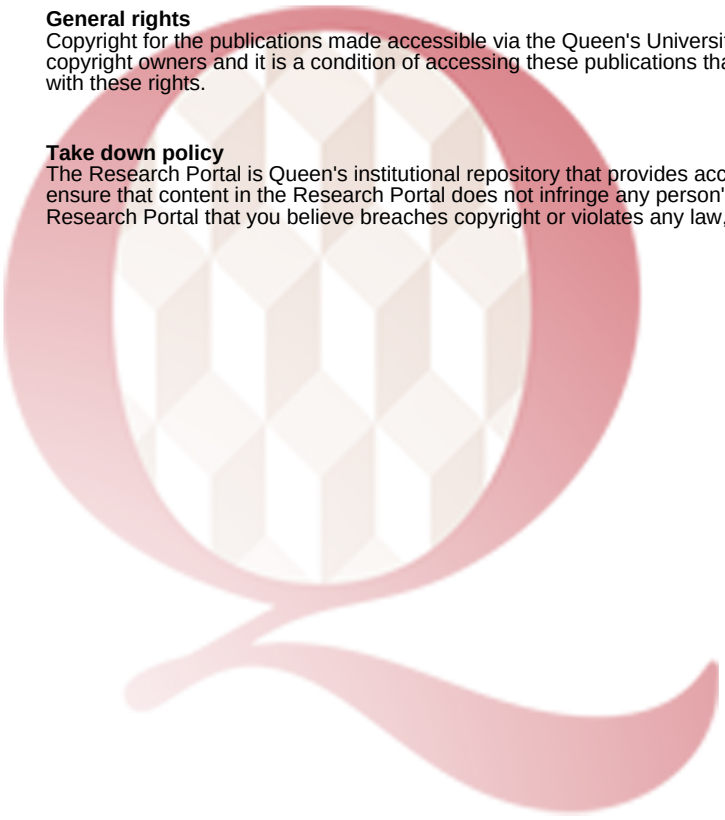
Alcohol attention bias in adolescent social drinkers: an eye tracking study

Melaugh McAteer, A., Curran, D., & Hanna, D. (2015). Alcohol attention bias in adolescent social drinkers: an eye tracking study. Psychopharmacology, 232(17), 3183-3191. DOI: 10.1007/s00213-015-3969-z

Published in:
Psychopharmacology

Document Version:
Peer reviewed version



Authors: Annie Melaugh McAteer, Dr. David Curran, Dr. Donncha Hanna (Department of Psychology, Queen's University, Belfast).

Title: Alcohol Attention Bias in Adolescent Social Drinkers: An eye tracking study

Address: School of Psychology QUB, David Keir Building, 18 – 30 Malone Road, Belfast, Northern Ireland, BT9 5BN

Declaration of interest: Authors confirm there is no conflict of interest to declare.

Alcohol Attention Bias in Adolescent Social Drinkers: An eye tracking study

Abstract

Rationale: Previous research on attention bias in non-dependant social drinkers has focused on adult samples with limited focus on the presence of attention bias for alcohol cues in adolescent social drinkers.

Objectives: The aim of this study was to examine the presence of alcohol attention bias in adolescents and the relationship of this cognitive bias to alcohol use and alcohol related expectancies.

Methods: Attention bias in adolescent social drinkers and abstainers was measured using an eye tracker during exposure to alcohol and neutral cues. Questionnaires measured alcohol use and explicit alcohol expectancies.

Results: Adolescent social drinkers spent significantly more time fixating to alcohol stimuli compared to controls. Total fixation time to alcohol stimuli varied in accordance with level of alcohol consumption and was significantly associated with more positive alcohol expectancies. No evidence for automatic orienting to alcohol stimuli was found for adolescent social drinkers.

Conclusion: Attention bias in adolescent social drinkers appears to be underpinned by controlled attention suggesting that whilst participants in this study displayed alcohol attention bias comparable to that reported in adult studies the bias has not developed to the point of automaticity. Initial fixations appeared to be driven by alternative attentional processes which are discussed further.

Keywords Alcohol, Attention Bias, Eye tracking, Adolescent, Alcohol Expectancy

Introduction

Alcohol attention Bias

Cognitive theories of addiction emphasise both automatic and non-automatic processes in the development and maintenance of alcohol dependence (Mc Cusker, 2006; Robinson & Berrdige, 1993; Tiffany, 1990). Repeated consumption of alcohol causes adaptions in the dopamine system which results in the individual becoming sensitised to the effects of alcohol. Specifically the neural system associated with 'wanting' is altered and through associative learning wanting is focused on alcohol related stimuli (Robinson & Berrdige, 1993). Stimuli accompanying alcohol use are allocated incentive salience by the brain based on previous associations between stimuli and the rewarding effects of alcohol (Robinson & Berridge, 1993). This association becomes automatic and the processes that direct preferential attention to alcohol cues act outside of awareness. In this way interaction with alcohol related cues can influence alcohol use behaviours, for example, through triggering wanting and craving. This preferential attention as a result of stimuli salience is known as attention bias (AB), which is considered the behavioural manifestation of the appetitive processes underlying addictive behaviours (Robinson & Berrdige, 1993).

Until recently alcohol AB has been measured using reaction time tasks. Alcohol AB is inferred when colour naming on the modified stroop task is delayed for alcohol related words. On the dot probe task AB is assumed to facilitate faster reaction times to probes replacing alcohol related stimuli. Inferences from reaction times on these tasks provide an indirect measure of alcohol AB. They provide a snapshot of attention at any one time during stimuli presentation and therefore differences in the manifestation of AB across the attentional trajectory cannot be examined in detail. The presence of AB is well documented in studies of alcohol dependent participants (ADP) (Lusher, Chandler & Ball, 2004) and adult social drinkers (Miller & Fillmore, 2011; Schoenmakers & Wiers, 2010) employing these methods. The strength of AB appears to vary with levels of alcohol consumption; those with higher levels of alcohol use demonstrated a stronger AB (Schoenmakers, Wiers & Field, 2008; Fadardi & Cox, 2006; 2008; 2009) and participant's demonstrated biased attention for alcohol stimuli compared to neutral. However, it should be noted that not all studies support these findings (Loeber, Vollstädt-Klein, Von Der Goltz, Flor, Mann & Kiefer, 2009; Vollstädt-Klein, Loeber, Von Der Goltz, Mann & Kiefer, 2009).

Attempts to differentiate the attentional processes underlying alcohol AB have used variations in stimuli presentation time. Attention measured at shorter presentation times (up to 100ms) is thought to reflect initial orienting of attention whereas stimuli presented for longer times capture attentional processes under conscious control (Noël, Colmant, Van Der Linden, Bechara, Bullens,

Hanak & Verbanck, 2006). ADP demonstrate automatic orienting to alcohol stimuli, showing an alcohol AB when stimuli are presented briefly for 50ms, supporting theoretical assumptions that alcohol related cues automatically capture attention (Vollstädt-Klein et al. 2009 Noel et al., 2006) However, social drinkers appear to demonstrate alcohol AB later in stimuli presentation, when stimuli are presented between 500ms to 2000ms (Noël et al., 2006; Field, Mogg, Zetteler & Bradley, 2004; Stormark, Laberg, Nordby & Hugdahl, 2000). AB during longer presentation times as reported in social drinkers can be likened to 'sticky attention', characterised by a difficulty in disengaging attention from a stimulus in order to attend elsewhere (Sacrey, Bryson & Zwaigenbaum, 2013; Hanania & Smithe, 2010). Light drinkers and abstinent patient groups both demonstrate patterns of avoidance of alcohol cues in contrast to the approach bias demonstrated by heavy drinkers and ADP (Noel et al. 2006; Field et al. 2004). These findings suggest AB varies across populations and may be dependent on different underlying attentional systems. More recently studies have employed eye tracking to examine changes in more detail whilst participants completed tasks such as the dot probe paradigm (Miller & Fillmore, 2010; Schoenmakers et al. 2008). Findings from these studies support the general trend in studies employing other methodologies but eye tracking appears to be a more sensitive measure of attentional processing (Miller & Fillmore, 2011; Ceballos, Komogortsev & Turner, 2009).

Adolescent Alcohol use

A variety of factors contribute to differences between alcohol use in adolescent and adult social drinkers. A recent examination of alcohol use in social drinkers across Northern Ireland indicate that 75% of adults report drinking alcohol with 52% of these reporting weekly alcohol use (Department of Health, Social Services and Public Safety, 2011). Adolescent social drinkers report regular alcohol use with 69% of adolescents age 16 reporting alcohol use 'few' or 'many' times (Hannaford, 2005). Binge drinking has been reported by 21% of young people in an international study (Kann, Kinchen, Shanklin et al. 2014) and 30% of adult social drinkers (aged 18 – 29) in Northern Ireland report binge drinking (Department of Health, Social Services and Public Safety, 2011). Frequency of alcohol use in adolescent and adult samples is comparable to an extent however adults are more likely to consume greater amounts of alcohol (Department of Health, Social Services and Public Safety, 2011). Differences in alcohol use between adults and adolescents may provide an explanation as to any differences between adolescent and adult alcohol AB.

It is worth noting that as brain development continues well into adulthood it is important to consider any possible effects of adolescent brain development on measures of AB (Burgess, Simons, Dumontheil & Gilbert, 2005). The visual cortex reaches full maturation by 10 years of age (Huttenlocher, 1990) and linguistic processing reaches maturation by 11 years of age (Teffer &

Semenderferi, 2012) therefore variation in visual capacity or language abilities of the participants and adults that would impact on measurements used. The frontal lobe is of particular interest due to its role in executive functions such as maintenance of attention, working memory and goal directed behaviours (Teffer & Semendeferi, 2012). Areas associated with attention such as anteromedial areas of the frontal lobe, are some of the last areas to reach full maturation (Fuster, 2002; Barkovich, Kuzniecky, Jackson, Guerrini & Dobyns, 2005). The eye tracking task employed is free viewing and does not require complex executive functions. Therefore ongoing frontal lobe development will not confound measures of AB. In light of these findings and without longitudinal studies examining attention changes it is assumed that any differences between adult and adolescent alcohol AB is not a result of differences in brain maturation.

Despite reports of regular alcohol use in adolescence and the increased vulnerability of young people developing alcohol misuse difficulties in adulthood as a result of previous alcohol use (Burrow-Sanchez, 2006) there is limited understanding of alcohol AB in adolescent population. A detailed understanding of the processes contributing to misuse problems is key to prevention and intervention. Using the stroop task Field et al., (2007) reported that heavy drinking adolescents demonstrated an alcohol AB whereas light drinkers did not. AB was significantly correlated with number of drinks per week suggesting that increased alcohol use was associated with stronger alcohol AB, as reported in adult studies. However, no clear differences between heavy and light drinkers are reported (Field et al., 2007). Findings of an alcohol AB study in adolescent social drinkers using a supraliminal modified stroop task are also reported (Zetteler et al., 2006). However, this was specific to adolescents with an alcohol dependent parent and generalisations of social drinkers cannot be made.

Given that alcohol AB is cited as a contributor to the development and maintenance of alcohol misuse it is important to understand how it manifests in adolescent social drinkers. An understanding of the attentional processes that underlie it may provide an additional way to identify young people who are at risk of later alcohol misuse. This study aims to expand on current knowledge using a direct measure of attention to examine alcohol AB in adolescent social drinkers. In addition to examining the relationship between alcohol use and alcohol AB, this study will also look at the relationship between alcohol expectancies and AB. The automatic network theory suggests that alcohol expectancies and AB can co-vary to bring about alcohol use with alcohol dependence characterised by automatic triggering of autonomic, attentional and propositional responses. (Mc Cusker, 2006). Adolescent heavy drinkers show more positive alcohol expectancies with regard to alcohol use compared to light drinking and abstaining peers (McKay, Sumnall, Goudie, Field & Cole, 2011; Cable & Sacker, 2008; Callas, Flynn & Worden, 2004). The role of expectancies in predicting adolescent alcohol use has been well documented; however, the

relationship between alcohol AB, expectancies and alcohol use in this population is less clear. It is predicted that adolescent social drinkers would preferentially attend to alcohol compared to control group of abstainers. It was also predicted that those who report higher levels of alcohol use will report more positive expectancies about alcohol use and demonstrate a stronger alcohol AB.

Methods

Participants

Adolescents (n = 68) were recruited from schools in Northern Ireland. Forty four participants (15 females) were included in the final analyses (mean age = 17 years, 1 month; range 16-19). Participants completed the AUDIT and were divided into one of three groups based on scores; heavy drinkers (scores > 8), light drinkers (scores 1 – 8) and abstainers (scores 0). All participants had normal or corrected to normal vision and English as their first language. The study received ethical approval from the School of Psychology, Queen's University, Belfast.

Materials

Questionnaires The Alcohol Use Disorders Identification Test (AUDIT; Allen, Litten, Fertig, Babor, 1997) is a screening tool developed by the World Health Organisation to measure harmful and hazardous alcohol use. Three sections measure alcohol use (items 1-3), dependence symptoms (items 4 -6) and alcohol related consequences (items 7 – 10).

The Alcohol Expectancy Questionnaire – Adolescent (AEQ-A; Brown, Christiansen & Goldman, 1987) measured alcohol expectancies across seven scales; cognitive and motor impairment, increased arousal, relaxation and tension reduction, global positive changes, changes in social behaviour, improved cognition and motor ability and sexual enhancement. Participants are asked to respond to statements about the effects of alcohol use in general terms, meaning the questionnaire can be used with adolescents irrespective of their personal alcohol use.

A short questionnaire regarding demographic information was also completed.

Attention Bias Attentional processing was measured using a table mounted RED eye-tracker, (SMI, 2010) and stimuli were presented on a 22inch monitor with infrared optics attached to the bottom of the screen. Eye saccades were recorded at 250Hz.

Stimuli Images came from several searches on the internet. Alcohol related pictures where matched to neutral pictures based on complexity, colour and size. Word stimuli were matched on first letter, frequency of use and number of syllables (see figure 1 for examples). These stimuli were rated on alcohol relatedness and emotional valence by a group of 17 year olds and by a group of independent researchers. Only alcohol stimuli rated as 'alcohol related' and "not very emotional' were included as

alcohol stimuli. Neutral stimuli rated as 'not emotional' and 'not alcohol related' were included in the neutral pool.

Figure 1: Example of simple, complex and word stimuli pairs used to measure alcohol AB

GIN **GUM**

Participants were invited to take part in a study examining attentional processing. They completed the eye tracking component first to avoid priming of attention by the alcohol related content of questionnaires. A nine point calibration was used to ensure accuracy of eye movement measurement. Experimental stimuli consisted of 60 alcohol stimuli (20 simple images, 20 complex images and 20 words) matched to a neutral stimuli. These pairs were interspersed at random with 30 neutral pairs to avoid priming by alcohol content of the study. Trials were divided into blocks of three based on stimuli complexity and participants were offered a break between each block if needed. Ten neutral pairs were included as a practice trial before the experimental trials began. Participants were seated 60cm from the screen and asked to look at stimuli pairs like they would a computer pop-up in order to gain a natural measure of attention. Pairs were presented for 2500ms each with a fixation cross presented between each pair for 1000ms. After eye tracking was completed participants completed questionnaires measuring explicit alcohol expectancies, alcohol use, and demographic information before being debriefed. Alcohol related stimuli appeared on the left and right hand side of the screen an equal number of times to control for the possible confounding effects of a left gaze bias.

Data preparation Data from the eye tracker was coded based on areas of interest (AOI). These were alcohol and neutral AOI's and only experimental trials were coded. A border was hand drawn

1cm around each stimulus and all fixations which fell within this border were taken as a fixation to the AOI. All other fixations outside of these areas including fixations to white areas, fixations off-screen and blinks were excluded from the analysis. Fixations were defined as focus of attention to one point for 100ms or more. Initial fixation was defined as the first fixation to fall within either AOI after stimuli pairs replaced the central fixation dot and this was taken as a measure of automatic orienting. Total fixation time was taken as a measure of controlled attention and was calculated as the total time spent fixating to each AOI. Fixations to each AOI are reported as percentages of overall fixation time to AOI's to allow comparison across participant groups.

Whilst all possible measures were taken to optimise the success of the eye tracking measure several factors resulted in unsuccessful calibration. These included restrictions when calibrating participants with dark rimmed glasses or wearing eye-makeup and this resulted in 9 participants being excluded. Any participant with a mean calibration $>1^0$ (across X and Y co-ordinates) where excluded as calibrations above this where deemed be lacking accuracy and 11 participants were excluded at this point. Finally, four participants reporting previous head injury or diagnosis of psychological disorders were excluded to control for the confounding effects of these on attentional processing.

Results

Participant demographics As shown in Table 1 heavy drinkers (n= 17) scored highest on the AUDIT for alcohol use followed by light drinkers (n=15) with all abstainers scoring 0 (n=12). No significant difference on age of first drink was found for heavy and light drinkers (Heavy drinkers = 14.12 years (range 9 – 16years) and light drinkers = 15.07 years (range 9 – 17 years). Seventy six point five percent of heavy drinkers reported their last drink to be less than one week before testing whereas 26.7% of light drinkers reported last drink to be within one week of testing. Abstainers reported having never tried alcohol.

Scores on question one and two of the AUDIT were analysed to examine frequency and quantity of alcohol use. *Frequency* In response to question one 6.25% of heavy drinkers reported drinking two to three times per week 75.00 % reported drinking 2 to 4 times per month and 18.75% reported drinking monthly or less. In comparison, 68.75% of light drinkers reported alcohol use monthly or less and 31.25% reported drinking alcohol 2 to 4 times per month. *Quantity* Volume of alcohol use was measured by response to question two 'How many drinks containing alcohol do you have a on a typical day when you are drinking? Heavy drinkers reported drinking more alcohol on each drinking occasion. 31.3% reported drinking 10 or more drinks, 25.00% reported drinking 7, 8 or 9 drinks and 43.75% reported having 5 or 6 drinks. For light drinkers 31.25% reported drinking

5 or 6 drinks, 43.75% reported having 3 or 4 drinks and 18.75% of light drinkers reported having 1 or 2 drinks on each drinking occasion.

There was a significant main effect of group on alcohol expectancy scores (F (2, 42) = 11.737, p <.001) with post hoc tests indicating a significantly higher expectancy score in heavy drinkers (t (27) = 4.68. p < .001) and light drinkers (t (27) = 3.66, p = .002) compared to abstainers (Table 1). Heavy drinkers scored significantly higher on the sub-scales of positive global changes (t (27) = 2.88 p = .019), changes in social behaviour (t (27) = 6.44, p <.001), improved cognition (t (27) =2.98, p = .015) and motor abilities compared to abstainers (t (27) = 2.64, p = .035 respectively). Light drinkers scored significantly higher on the social behaviour scale compared to abstainers (t (25) = 5.14, p <.001). Statistical analyses revealed no differences between males and females on AUDIT score.

Table 1: Descriptive statistics for alcohol use, and alcohol expectancy score on individual expectancy scales for heavy light and non-drinking groups

	Total (n)	Mean age (standard deviation)	AUDIT mean (standard deviation)	AUDIT Range (possible range 0 to 20)	AEQ-A (Standard Deviation)	Global Positive Changes	Changes in social Behaviour (Standard Deviation)	Improved Cognition and motor abilities (Standard Deviation)	Sexual Enhancement (Standard Deviation)	Cognitive and motor impairment (Standard Deviation)	Increased Arousal (Standard Deviation)	Relaxation and tension reduction (Standard Deviation)
Heavy drinker	17	16.92 (48.34)	12.53 (3.78)	9 – 20	22.65 (7.47)	8.86 (3.31)	11.65 (2.34)	1.47 (1.18)	4.53 (1.84)	20.94 (3.83)	6.24 (2.02)	11.06 (1.89)
Light drinker	15	17.87 (7.65)	4.60 (2.17)	2 - 8	19.57 (11.12)	7.86 (3.13)	10.57 (2.56)	1.00 (0.88)	4.21 (2.19)	20.79 (1.89)	5.21 (2.08)	10.00 (3.21)
Abstainers	12	16.06 (31.56)	0 (0.00)	0	6.08 (9.62)	5.33 (2.50)	5.25 (3.08)	.42 (.51)	4 (2.04)	21.33 (2.53)	4.75 (2.73)	8.17 (3.64)

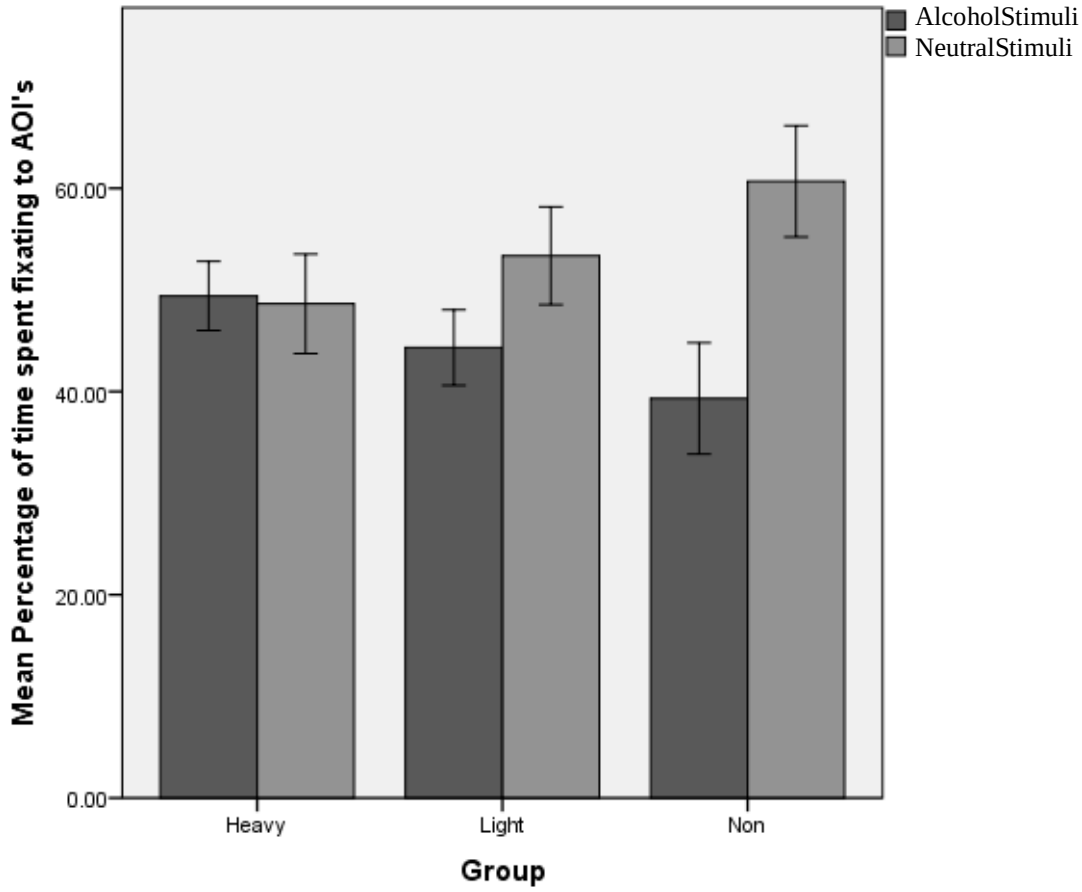
Measures of attention bias (AB)

Controlled Attention

Means show that heavy drinkers spent longest fixating to alcohol stimuli, followed by light drinkers and abstainers spent least amount of time fixating on alcohol cues (Figure 2).

There was a significant main effect of group for the total mean fixation time to alcohol stimuli (F (2, 43) = 6.91, p = .003). Bonferroni post hoc tests show that heavy drinkers spent significantly longer (t (27) = 3.70, p = .002) fixating to alcohol stimuli than abstainers (49.41% and 39.32% of total fixation time to alcohol cues respectively). Statistical analyses showed no within group differences were found between alcohol and neutral stimuli.

Figure 2: Bar chart showing total fixation time to alcohol and neutral stimuli for three experimental groups. Error bars show standard error.



Automatic attention

There was no significant main effect of group on first fixation to alcohol or neutral stimuli. Drinkers did not fixate more quickly to alcohol stimuli compared to abstainers and no significant difference

was found for speed of fixation to alcohol and neutral stimuli.

Early versus late attention

In order to examine if alcohol attention bias is underpinned by early or late attentional processes the data set was divided into two sections (Laidlaw, Risko & Kingstone, 2012). The first half (0 – 1249ms) was taken as a measure of early viewing period whereas the latter half was taken as a measure of prolonged or sticky attention (1500ms – 2500ms). Means are shown in Table 2. No significant main effect for total mean fixation time to alcohol stimuli was found for the first half of stimuli presentation. A significant main effect of group was found for total fixation time to alcohol stimuli in the second half of the presentation time (F (2, 43) = 4.108, p = .024). Post hoc tests indicate that heavy drinkers spent significantly longer fixating to alcohol stimuli compared to abstainers during the latter half of the presentation (t (27) = 2.66, p = .033).

Table 2: Mean percentage of fixations to alcohol and neutral stimuli during first and second section of stimuli presentation

	Time of presentation	Heavy Drinkers (Standard Deviation)	Light Drinkers (Standard Deviation)	Abstainers (Standard Deviation)
Mean fixation time to alcohol stimuli	0-1249ms	48.62 (5.68)	51.22 (5.78)	50.35 (5.08)
	1250ms – 2500ms	48.16 (12.69)	47.21 (10.59)	35.84 (13.59)
Mean fixation time to neutral stimuli	0-1249ms	51.22 (5.68)	48.78 (5.78)	49.65 (5.08)
	1250ms – 2500ms	51.84 (12.69)	52.80 (10.59)	64.16 (13.59)

Left Gaze Bias

All participants fixated to the left side of the screen most often with their first fixation irrespective of alcohol use or stimuli type. Heavy drinkers fixated left with first fixation 62% of the time, light drinkers 64% and abstainers fixated to the left hand side of the screen 56% of first fixations.

Correlations between psychometric measures

Alcohol use correlated with expectancy score (r (43) = .480, p =.001) and with expectancy sub-scales of positive changes (r (43) = .398, p = .008), social behaviour (r (43) = .633, p <.001) improved cognitive and motor skills (r (43) = .391, p = .010).

Psychometric questionnaires and behavioural measures

Total fixation time to alcohol stimuli correlated with alcohol use (r (43) = .419, p = .005), expectancy score (r (43) = .419, p = .005) and with sub-scales global positive changes (r (43) = .316, p = .039), changes in social behaviour (r (43) = .477, p =.001),improved cognitive and motor ability (r (43) = .335, p = .028), and relaxation (r (43) = .475, p = .001).

Discussion

Summary

Findings indicate that an alcohol AB was present in this sample of adolescents; social drinkers spent more of their total fixation time looking to alcohol stimuli compared to controls. These findings support previous work in both adolescent (Field et al., 2007) and adult populations (Miller & Fillmore, 2011; Schoenmakers & Wiers, 2010; Lusher et al., 2004).

Presence of alcohol attention bias

Drinkers fixated to alcohol stimuli more compared to abstainers during the second half of stimuli presentation indicative of sticky attention. This 'sticky attention' in adolescent social drinkers is comparable to that of adults (Vollstädt-Klein et al., 2009; Loeber et al., 2009; Noel et al., 2006; Townshend & Duka, 2001) and at-risk adolescents who only demonstrated AB during supraliminal stroop task, (Zetteler et al. 2006). Through the use of eye tracking this study pinpoints the presence of alcohol AB only during the latter half of stimuli presentation in adolescent social drinkers.

Adolescent social drinkers did not fixate automatically or more quickly to alcohol related stimuli. Theoretical models predict automaticity in AB but findings indicate an absence of such automaticity in this population (Mc Cusker, 2006; Robsinson & Berrdige, 1993). Automatic orienting may be the hallmark of alcohol dependence, however preferential attention found in social drinkers may be a result of familiarity and not indicator of misuse. Alternatively the lack of automaticity reported here may be due to lack of alcohol use experience whereby limited pairings between alcohol use and alcohol related stimuli is not sufficient for AB to reach automaticity in both adolescent and adult social drinkers. However, AB in adult social drinkers has not been examined using a free viewing task and therefore generalisations cannot be made. Longitudinal studies examining the development of alcohol AB as alcohol use continues would allow an

examination of this in more detail as would comparisons of alcohol AB in adult and adolescent social drinkers using identical tasks.

Previous work has suggested that initial attentional processes are driven by factors such as salience (Freeth, Foulsham & Chapman, 2011). In this instance automatic attention may have been driven by processes which override alcohol AB. One possibility for this is left gaze bias. To date a strong literature base supports the presence of left gaze bias when examining studies of facial perception and reading direction (Guo, Smith, Powell & Nicholls, 2012; Heath, Rouhana & Ghanem, 2005) whereas evidence appears to be less clear in relation to viewing pictures (Leonards & Scott- Samuel, 2005). Left gaze bias has not been addressed in AB research to date, possibly due to the absence of AB studies in non-clinical populations. In clinical populations AB may have reached automaticity and therefore any left gaze bias is diluted. Strong evidence for such a bias was found in this study with all groups fixating to the left hand side of the screen more often with their first fixation. If AB is yet to reach automaticity in social drinkers left gaze bias may be the dominant process driving automatic attention. This bias is thought to be a result of hemispheric specialisation, strengthened by the propensity of English speakers to read left to right (Guo, Smith, Powell & Nicholls, 2012). These processes are well practiced in older adolescents and therefore may take precedence in driving automatic attention.

The absence of automaticity in the alcohol AB of adolescent social drinkers has clinical implications. Early interventions to reduce bias in at risk adolescents or those with harmful levels of alcohol use could prevent attentional processing reaching automaticity and therefore reduce the impact of automatic orienting on alcohol use and craving. Training programmes implemented to reduce alcohol AB have had limited efficacy (Schoenmakers, Wiers, Jones, Bruce & Jansen, 2007; Field, Duka, Eastwood, Child, Santarcangelo & Gayton, 2007; Field & Eastwood, 2005). Such interventions may be more advantageous at earlier stages where AB is still under the influence of controlled attention and associations between alcohol use and alcohol cues can be extinguished before automaticity is reached.

Alcohol Use and Alcohol AB strength

Studies of AB in adult populations have indicated a clear pattern with level of alcohol consumption being associated with AB strength and studies of adolescent social drinkers have indicated this trend (Miller & Fillmore, 2011; Field et al., 2007; Fadardi & Cox, 2006; 2008; 2009). Findings from the current study suggest that stronger alcohol AB is related to alcohol consumption in adolescence; differences between heavy and light drinkers indicate that despite limited alcohol use adolescent social drinker's differences in AB strength have started to emerge. This finding is further supported by the fact alcohol use was significantly correlated with total fixation time. Absence of alcohol AB

in the control group supports the theoretical assumption that alcohol use is required for the development of alcohol AB (Mc Cusker, 2006). It has been previously suggested that avoidance bias in light drinkers can be explained by lack of interest in alcohol stimuli to this group and therefore preferential attention would not benefit them (Vollstädt-Klein et al., 2009). Abstainers spent significantly longer fixating to neutral stimuli and, similar to light drinkers, this may be the result of lack of interest in alcohol stimuli.

Alcohol Expectancies

In line with previous work adolescent drinkers in this study had more overall positive expectancies regarding alcohol use than abstainers (McKay et al. 2011; Cable & Sacker, 2008; Callas et al., 2004) and more positive expectancies about the effects of alcohol use on improved social behaviours (Killen, Hayward, Wilson, Haydel, Robinson, Taylor et al. 1996). The results indicated more positive expectancies regarding improved cognitive and motor skills and global positive changes, similar to studies examining expectancies in adolescents with at-risk of alcohol misuse (Mann, Chassin & Sher, 1987; Brown, Creamer & Stetson, 1987; Christiansen & Goldman, 1983). However, this study focused on social drinkers and therefore cannot be compared directly to a sample of at-risk adolescents. Theoretical models suggest that alcohol expectancies and alcohol AB can co-vary to bring about alcohol use, relapse and cravings. Findings from this study go some way to support this assumption as more positive alcohol expectancies were associated with longer total fixation time to alcohol cues.

The study is not without limitations. Reports of alcohol use are based on responses to items on the AUDIT and therefore are potentially subject to self-report bias. The precise relationship between alcohol AB, alcohol use and alcohol expectancies is still unclear and future research should examine co-variation between such variables in more detail. The presence of a left gaze bias can be influenced by laterality of participants; however this was not measured in the current population (Guo et al., 2012). Future work in this area would benefit from an examination of how alcohol AB manifestations change as alcohol use continues across the developmental trajectory from adolescence to adulthood.

In summary alcohol AB is present in this sample of adolescent social drinkers and it appears to be regulated by controlled attentional processes. Despite limited alcohol use, alcohol AB is comparable to that found in adult social drinkers suggesting a rapid development of AB once alcohol use commences. The strength of the bias demonstrated is related both to the amount of alcohol consumed and the positive expectancies adolescents have regarding alcohol use.

References

Allen, J. P., Litten, R. Z., Fertig, J. B., & Babor, T. (1997). A review of research on the alcohol use disorders identification test (AUDIT). Alcoholism: Clinical and Experimental Research 21:613-619.

Armstrong, T., & Olatunji, B. O. (2012). Eye tracking of attention in the affective disorders: A meta-analytic review and synthesis. *Clinical Psychology Review, 32*(8), 704-723.

Barkovich, A. J., Kuzniecky, R. I., Jackson, G. D., Guerrini, R., & Dobyns, W. B. (2005). A developmental and genetic classification for malformations of cortical development.*Neurology, 65*(12), 1873-1887

Brown, S. A., Christiansen, B. A., & Goldman, M. S. (1987). The alcohol expectancy questionnaire: An instrument for the assessment of adolescent and adult alcohol expectancies. Journal of Studies on Alcohol and Drugs 48:483 – 491.

Brown, S. A., Creamer, V. A., & Stetson, B. A. (1987). Adolescent alcohol expectancies in relation to personal and parental drinking patterns. Journal of Abnormal Psychology 96: 117 - 121.

Bunge, S. A., Dudukovic, N. M., Thomason, M. E., Vaidya, C. J., & Gabrieli, J. D. (2002). Immature frontal lobe contributions to cognitive control in children: Evidence from fMRI.*Neuron, 33*(2), 301-311.

Burgess, W, P., Simons, S, J., Dumontheil, I & Gilbert, S. (2005). Chapter 9: The Gateway Hypothesis of Rostral Prefrontal Cortex (Area 10) function). In J. Duncan, L. Phillips & P. McLeod (eds) Measurting the Mind: Speed, Control and Age. Oxford University Press, Oxford, pp 217 – 248.

Burrow-Sanchez, J. J. (2006). Understanding adolescent substance abuse: Prevalence, risk factors, and clinical implications. *Journal of Counseling & Development, 84*(3), 283-290.

Cable, N., & Sacker, A. (2008). Typologies of alcohol consumption in adolescence: Predictors and adult outcomes. Alcohol and Alcoholism 43:81-90.

Callas, P. W., Flynn, B. S., & Worden, J. K. (2004). Potentially modifiable psychosocial factors associated with alcohol use during early adolescence. Addictive Behaviors 29: 1503-1515.

Ceballos, N. A., Komogortsev, O. V., & Turner, G. M. (2009). Ocular imaging of attentional bias among college students: Automatic and controlled processing of alcohol-related scenes. Journal of Studies on Alcohol and Drugs 70: 652- 659.

Christiansen, B. A., & Goldman, M. S. (1983). Alcohol-related expectancies versus demographic/background variables in the prediction of adolescent drinking. Journal of Consulting and Clinical Psychology 51:249 – 257.

Department of Health, Social Services and Public Safety. (2011). *Adult Drinking Patterns in Northern Ireland*. Department of Health, Social Services and Public Safety.

Fadardi, J. S., & Cox, W. M. (2006). Alcohol attentional bias: Drinking salience or cognitive impairment? Psychopharmacology 185:169-178.

Durston, S., Thomas, K. M., Yang, Y., Uluğ, A. M., Zimmerman, R. D., & Casey, B. (2002). A neural basis for the development of inhibitory control. *Developmental Science, 5*(4),

Fadardi, J. S., & Cox, W. M. (2008). Alcohol-attentional bias and motivational structure as independent predictors of social drinkers' alcohol consumption. Drug and Alcohol Dependence 97: 247-256.

Fadardi, J. S., & Cox, W. M. (2009). Reversing the sequence: Reducing alcohol consumption by overcoming alcohol attentional bias. Drug and Alcohol Dependence 101:137-145.

Field, M., Christiansen, P., Cole, J., & Goudie, A. (2007). Delay discounting and the alcohol stroop in heavy drinking adolescents. Addiction 102:579-586.

Field, M., Duka, T., Eastwood, B., Child, R., Santarcangelo, M., & Gayton, M. (2007). Experimental manipulation of attentional biases in heavy drinkers: Do the effects generalise? Psychopharmacology 192:593-608.

Field, M., & Eastwood, B. (2005). Experimental manipulation of attentional bias increases the motivation to drink alcohol. Psychopharmacology *183*(3), 350-357.

Field, M., Mogg, K., Zetteler, J., & Bradley, B. P. (2004). Attentional biases for alcohol cues in heavy and light social drinkers: The roles of initial orienting and maintained attention. Psychopharmacology 176:88-93.

Freeth, M., Foulsham, T., & Chapman, P. (2011). The influence of visual saliency on fixation patterns in individuals with autism spectrum disorders. Neuropsychologia 49:156-160.

Fuster, J. M. (2002). Frontal lobe and cognitive development. *Journal of Neurocytology, 31*(3-5), 373-385.

Guo, K., Smith, C., Powell, K., & Nicholls, K. (2012). Consistent left gaze bias in processing different facial cues. Psychological Research *76:* 263-269.

Hannaford, Sarah., (2005). Drinking, Smoking, Drugs and Sexual Intercourse – Eduction and influences for Young People in Northern Ireland. ARK Research Update, Belfast: Ark <http:www.ark.ac.uk/publications/updates/update37.pdf>

Hanania, R., & Smith, L. B. (2010). Selective attention and attention switching: Towards a unified developmental approach. Developmental Science *13:* 622-635.

Heath, R., Rouhana, A., & Abi Ghanem, D. (2005). Asymmetric bias in perception of facial affect among roman and arabic script readers. *Laterality: Asymmetries of Body, Brain, and Cognition*, *10*(1), 51-64.

Huttenlocher, P. R. (1990). Morphometric study of human cerebral cortex development. *Neuropsychologia*, *28*(6), 517-527.

Kann, L., Kinchen, S., Shanklin, S. L., Flint, K. H., Kawkins, J., Harris, W. A., . . . Chyen, D. (2014). Youth risk behavior surveillance—United states, 2013. *MMWR Surveill Summ,63*(Suppl 4), 1-168.

Killen, J. D., Hayward, C., Wilson, D. M., Haydel, K. F., Robinson, T. N., Taylor, C. B. et al. (1996). Predicting onset of drinking in a community sample of adolescents: The role of expectancy and temperament. Addictive Behaviors *21:*473-480.

Laidlaw, K. E., Risko, E. F., & Kingstone, A. (2012). A new look at social attention: Orienting to the eyes is not (entirely) under volitional control. Journal of Experimental Psychology: Human Perception and Performance *38:*1132 – 1142.

Leonards, U., & Scott-Samuel, N. E. (2005). Idiosyncratic initiation of saccadic face exploration in humans. *Vision Research*, *45*(20), 2677-2684.

Loeber, S., Vollstädt-Klein, S., Von Der Goltz, C., Flor, H., Mann, K., & Kiefer, F. (2009). Clinical study: Attentional bias in alcohol-dependent patients: The role of chronicity and executive functioning. Addiction Biology *14*:194-203.

Lusher, J., Chandler, C., & Ball, D. (2004). Alcohol dependence and the alcohol stroop paradigm: Evidence and issues. Drug and Alcohol Dependence 75: 225-231.

Mann, L. M., Chassin, L., & Sher, K. J. (1987). Alcohol expectancies and the risk for alcoholism. Journal of Consulting and Clinical Psychology *55:* 411.

McKay, M. T., Sumnall, H., Goudie, A. J., Field, M., & Cole, J. C. (2011). What differentiates adolescent problematic drinkers from their peers? Results from a cross-sectional study in northern Irish school children. Drugs: Education, Prevention and Polic, 18*:*187-199.

McCusker, C. (2006). Towards understanding loss of control: An automatic network theory of addictive behaviours. In: Munafó, M & Alberry, I (ed) Cognition and Addiction, 1st Edn. Oxford University Press, pp117-146.

Miller, M. A., & Fillmore, M. T. (2011). Persistence of attentional bias toward alcohol-related stimuli in intoxicated social drinkers. Drug and Alcohol Dependence 117:184 – 189.

Miller, M. A., & Fillmore, M. T. (2010). The effect of image complexity on attentional bias towards alcohol-related images in adult drinkers. Addiction 105:883-890.

Noël, X., Colmant, M., Van Der Linden, M., Bechara, A., Bullens, Q., Hanak, C., & Verbanck, P. (2006). Time course of attention for alcohol cues in abstinent alcoholic patients: The role of initial orienting. Alcoholism: Clinical and Experimental Research 30:871-1877.

Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: An incentive-sensitization theory of addiction. Brain Research Reviews, 18:247-291.

Sacrey, L. R., Bryson, S. E., & Zwaigenbaum, L. (2013). Prospective examination of visual attention during play in infants at high-risk for autism spectrum disorder: A longitudinal study from 6 to 36 months of age. Behavioural Brain

Research 256:441-450.

Schoenmakers, T., & Wiers, R. (2010). Craving and attentional bias respond differently to alcohol priming: A field study in the pub. European Addiction Research 16:9-16.

Schoenmakers, T., Wiers, R. W., & Field, M. (2008). Effects of a low dose of alcohol on cognitive biases and craving in heavy drinkers. Psychopharmacology 197: 169-178.

Schoenmakers, T., Wiers, R. W., Jones, B. T., Bruce, G., & Jansen, A. (2007). Attentional re-training decreases attentional bias in heavy drinkers without generalization. Addiction 102: 399-405.

Teffer, K., & Semendeferi, K. (2012). 9 human prefrontal cortex: Evolution, development, and pathology. *Progress in Brain Research, 195*, 191.

Stormark, K. M., Laberg, J. C., Nordby, H., & Hugdahl, K. (2000). Alcoholics' selective attention to alcohol stimuli: Automated processing? *Journal of Studies on Alcohol and Drugs,61*(1), 18.

Teffer, K., & Semendeferi, K. (2012). 9 human prefrontal cortex: Evolution, development, and pathology. *Progress in Brain Research, 195*, 191.

Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behaviour: Role of automatic and non-automatic processes. Psychological Review 97:147- 168.

Townshend, J., & Duka, T. (2001). Attentional bias associated with alcohol cues: Differences between heavy and occasional social drinkers. Psychopharmacology 157:67-74.

Vollstädt-Klein, S., Loeber, S., Von Der Goltz, C., Mann, K., & Kiefer, F. (2009). Avoidance of alcohol-related stimuli increases during the early stage of abstinence in alcohol-dependent patients. Alcohol and Alcoholism 44:458-463.

Zetteler, J. I., Stollery, B. T., Weinstein, A. M., & Lingford-Hughes, A. R. (2006). Attentional bias for alcohol-related information in adolescents with alcohol-dependent parents. Alcohol and Alcoholism 41:426- 230.